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Technology Center 2100

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/610,094
Filing Date: June 30, 2000
Appellant(s): CRABTREE ET AL.

Brian T. Sattizahn
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 10/17/05 appealing from the Office action mailed 3/7/05.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings, which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

No evidence is relied upon by the examiner in the rejection of the claims under appeal.

(9) Grounds of Rejection

The following ground of rejection is applicable to the appealed claims:

Claim Rejections - 35 USC § 103

5. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 1-20 are rejected under 35 U.S.C. 103 (a) as unpatentable by Barka et al., ("An Efficient Algorithm for the RCS Modulation Prediction from Jet Inlet Engines" (1999)) in view of D' Angelo et al., ("A New Finite Element Formation for RF Scattering by Complex Bodies of Revolution" (1993)).

Barka et al. teaches using electromagnetic scattering from the interior of a complex jet engine inlet to contribute to the overall radar cross section (RCS) of a modern jet aircraft; but does not teach specific axi-symmetric aircraft related devices. D'

Angelo et al. teaches solving electromagnetic scattering from complex inhomogeneous axi-symmetric bodies using finite element analysis.

At the time the invention, it would have been obvious to one of ordinary skill in the art to use Barka et al. to modify D' Angelo et al. since it would be advantageous to capture the RCS from another dimension in space for a precise 3-D representation (D'Angelo: pg. 534, right column 2nd paragraph, lines 1-15 with equations 1,2).

Claim 1. A method of calculating a radar cross section of an aircraft component having an axi-periodic structure comprising the steps of (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract): creating a finite element model for the aircraft component describing electromagnetic characteristics of the aircraft component (Barka: pg. 2566, Introduction); transforming the finite element model into a plurality of independent modes (Barka: pg. 2567, lines 11-12); determining, for each independent mode of the plurality of independent mode (Barka: pg. 2566, lines 19-22); a portion of an electromagnetic field contributed by each independent mode (Barka: pg. 2567, lines 11-12); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic field for the aircraft component (D'Angelo: pg. 538, equation 21); and determining the radar cross section for the aircraft component from the total electromagnetic field (Barka: Introduction; D'Angelo: section III, Radar Cross Section Calculation, pg.537-539).

Claim 2. The method of claim 1 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of creating a finite element model for the aircraft component further comprises the step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft component (Barka: Introduction and D'Angelo: pg. 536, figure 1a and 2a and 539-540, right column, lines 5-15 and left column, lines 1-8, respectively).

Claim 3. The method of claim 2 (Barka: Introduction; and D'Angelo: pg. 536, figure 1a and 2a and 539-540, right column, lines 5-15 and left column, lines 1-8, respectively) and wherein said step of transforming the finite element model into a plurality of independent modes further comprises the additional steps of: assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft component; and applying a Discrete Fourier Transform to the system matrix (D'Angelo: pg.537, equation 20).

Claim 4. The method of claim 1(Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of creating a finite element model for the aircraft component further comprises the step of creating the finite element model using second order edge elements (D'Angelo: pg. 535, equation 13).

Claim 5. The method of claim 4 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the second order edge elements (D'Angelo: pg. 536, left column, lines 6-8) are curl conforming type elements (D'Angelo: pg. 535, equation 13).

Claim 6. The method of claim 1 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of creating a mathematical representation of a reference pipe having an infinite length (D'Angelo: pg.540, lines 8-31); and using the mathematical representation of the reference pipe to determine the portion of the electromagnetic field contributed by each independent mode (D'Angelo: pg. 539-540, Results and Discussion).

Claim 7. The method of claim 6 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of creating a mathematical representation (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) of a test fixture; creating a mathematical representation of the aircraft component in a cavity (Barka: pg. 2566, lines 17-19); coupling the mathematical representation of the test fixture to the mathematical representation of the aircraft component to create a mathematical representation of a combination of the test fixture and the aircraft

component (Barka: pg. 2568, figure 1 with pg.2566, lines 1-8 and 23); coupling the mathematical representation of the reference pipe(Barka: pg. 2567, lines 1-3) to the mathematical representation of the combination of the test fixture and the aircraft component to create a mathematical representation of the reference pipe (Barka: pg. 2567, lines 1-3), the test fixture and the aircraft component having a common interface between the test fixture and the reference pipe (Barka: pg. 2567, lines 1-3); and solving the mathematical representation of the reference pipe, the test fixture and the aircraft component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe (Barka: pg. 2568, figure 1 with pg.2566, lines 1-8 and 23).

Claim 8. The method of claim 7 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of creating a mathematical representation of a test fixture further comprises the additional steps of creating a single layer of finite elements describing electromagnetic characteristics of the test fixture (Barka: pg. 2566, lines 18-22); assembling a system matrix for the single layer of finite elements (Barka: pg. 2566, lines 18-24); factoring the system matrix for the single layer of finite elements into a test fixture impedance matrix, wherein the test fixture impedance matrix represents end surfaces of the test fixture having a length; and doubling the length of the test fixture represented by the test fixture impedance matrix until a preselected length of test fixture is represented by the test fixture impedance matrix (Barka: pg. 2566, lines 18-24).

Claim 9. The method of claim 8 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of creating a mathematical representation of a reference pipe having an infinite length further comprises the additional steps of (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31): copying the test fixture impedance matrix representing the test fixture of the preselected length to create a reference pipe impedance matrix, wherein the reference pipe impedance matrix represents end surfaces of the reference pipe having the preselected length; and doubling the length of the reference pipe represented by the reference pipe impedance matrix until a length of reference pipe is represented wherein the end surfaces of the reference pipe are uncoupled (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31).

Claim 10. The method of claim 7(Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the mathematical representation of the test fixture, the mathematical representation of the reference a pipe and the mathematical representation of the aircraft component, are each a super-element and the method further comprises the steps of storing the super-elements for the test fixture (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31), reference pipe and aircraft component in memory; modifying the aircraft component (Barka: pg. 2567, lines 1-13); and reusing stored super-elements for the test fixture and reference pipe to calculate a radar cross section for the modified aircraft component (Barka: pg. 2567, lines 5-11).

Claim 11. The method of claim 7(Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes (D'Angelo: pg. 540, lines 14-31); and determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft component and the solution of the representation of the two-sided reference pipe (Barka: pg. 2567, lines 11-13).

Claim 12. The method of claim 1 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the plurality of independent modes comprises primary modes and conjugate modes related to the primary modes and said step of determining, for each independent mode of the plurality of independent modes, the portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of determining an impedance matrix (Barka: pg. 2567, lines 26-34) for each primary mode of the plurality independent modes; and determining an impedance matrix (D'Angelo: pg. 539, right column lines 5-15 with pg. 540, lines 1-8) for each

conjugate mode by transposing the impedance matrix of the corresponding primary mode for each conjugate mode.

Claim 13. A computer program (Barka: pg. 2567, lines 5-12) product embodied on a computer readable medium and executable by a computer for calculating the radar cross section (RCS) of an aircraft engine face component, the computer program product comprising computer instructions for executing the steps of creating a finite element model for the aircraft engine face component describing electromagnetic characteristics of the aircraft engine face component (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract); transforming the finite element model into a plurality of independent modes(Barka: pg. 2567, lines 5-12); determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode (Barka: pg. 2567, lines 18-34); summing the portion of the electromagnetic field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic far-field for the aircraft engine face component (D'Angelo: pg. 537, equation 17); and determining the radar cross-section for the aircraft engine face component from the total electromagnetic far-field (D'Angelo: pg.537, equation 18).

Claim 14. The computer program product of claim 13 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the step of determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic field

contributed by each independent mode further comprises the additional steps of creating a mathematical representation of a test fixture (Barka: pg. 2566, lines 18-22); creating a mathematical representation of the aircraft engine face component in a cavity (Barka: pg. 2566, Introduction); creating a mathematical representation of a reference pipe having an infinite length; coupling the(Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); mathematical representation of the test fixture to the mathematical representation of the aircraft engine face component to create a mathematical representation of the combination of the test fixture and the aircraft engine face component (D'Angelo: pg. 535, equation 13 and pg. 536, left column, lines 1-4; with Barka: pg. 2566, Introduction); coupling the mathematical representation of the reference pipe to the mathematical representation of the combination of the test fixture and the aircraft engine face component to create a mathematical representation of the reference pipe, the test fixture and the aircraft component having a common interface between the test fixture and the reference pipe (D'Angelo: pg. 535, equation 13 and pg. 536, left column, lines 1-4; with Barka: pg. 2566, Introduction, and pg. 2567, lines 1-3); and solving the mathematical representation of the reference pipe, the test fixture and the aircraft engine face component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe (D'Angelo: pg. 540, conclusions with pg. 539 figures 7 and 8; with Barka: pg. 2567, lines 18-34).

Claim 15. The computer program product of claim 14 (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the step of determining, each independent

mode of the plurality of independent modes, a portion of an electromagnetic field contributed by each independent mode further comprises the additional steps of (D'Angelo: pg. 537, equation 20): coupling the mathematical representation of the reference pipe to another identical mathematical representation of the reference pipe to create a mathematical representation of a two-sided reference pipe having a common interface (D'Angelo: pg. 535, equation 13 with pg. 536, left column, lines 1-4; and Barka: pg. 2567, lines 1-3); solving the mathematical representation of the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes (D'Angelo: pg. 540, conclusions with pg. 539, figures 7 and 8; with Barka: pg. 2567, lines 18-34); and determining the difference between the solution of the representation of the reference pipe, test fixture and aircraft engine face component and the solution of the representation of the two-sided reference pipe (D'Angelo: pg. 540, conclusions with pg. 539, figures 7 and 8; with Barka: pg. 2567, lines 18-34).

Claim 16. The computer program product of claim 13 (Barka: pg. 2567, lines 5-12 and 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein the aircraft engine face component has an axi-periodic structure and said step of creating a finite element model for the aircraft engine face component comprises the additional step of creating a finite element model of a preselected period of the axi-periodic structure of the aircraft engine face component using second order edge elements (D'Angelo: pg. 536,lines 6-9).

Claim 17. A system for calculating the radar cross section (RCS) of an aircraft engine component comprising (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract): a computer having memory and a processing unit; means for creating a finite element model for the aircraft engine component describing electromagnetic characteristics of the aircraft engine component (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract); means for transforming the finite element model into a plurality of independent modes (Barka: pg. 2566, lines 11-18); means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field contributed by each independent mode (Barka: pg. 2566, lines 11-18 and pg. 2567, lines 21-22); and means for summing the portion of the electromagnetic near-field contributed by each independent mode of the plurality of independent modes to calculate a total electromagnetic near-field for the aircraft engine component(Barka: pg. 2566, lines 11-18); means for determining a total electromagnetic far-field for the aircraft engine component from the total electromagnetic near-field for the aircraft engine component (Barka: pg. 2566, lines 11-18); and means for determining the radar cross section for the aircraft engine component from the total electromagnetic far-field (Barka: pg. 2567, lines 18-34).

Claim 18. The system of claim 17 wherein: the aircraft engine component has an axi-periodic structure (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract); said means for creating a finite element model for the aircraft engine component (Barka: pg. 2566, lines 1-3 and 11): further comprises: means for creating a finite element

model of a preselected period of the axi-periodic structure of the aircraft engine component; and said means for transforming the finite element model into a plurality of independent modes further comprises: means for assembling a system matrix for the finite element model of the preselected period of the axi-periodic structure of the aircraft engine (Barka: pg. 2566, Introduction; and D'Angelo: abstract) component; and means for applying a Discrete Fourier Transform to the system matrix (D'Angelo: pg.537, equation 20).

Claim 19. The system of claim 1, (Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of an electromagnetic near-field (D'Angelo: equation 13 with section III Radar Cross Section Calculation) contributed by each independent mode comprises: means for creating an impedance matrix for a test fixture (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); means for creating an impedance matrix for the aircraft engine component in a cavity (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); means for creating an impedance matrix for a reference pipe having an infinite length (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); means for coupling the impedance matrix for the test fixture to the impedance matrix for the aircraft engine component to create an impedance matrix for the combination of the test fixture and the aircraft engine component (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); means for coupling the impedance matrix for the reference pipe to the impedance matrix for the combination of the test fixture and

the aircraft component to create an impedance matrix for the reference pipe, the test fixture and the aircraft engine component having a common interface between the test fixture and the reference pipe(Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31); and means for solving the impedance matrix for the reference pipe, the test fixture and the aircraft engine component by introducing a mathematical representation of an incident wave at the common interface of the test fixture and the reference pipe (Barka: pg. 2567, lines 1-3 and D'Angelo: pg. 540, lines 14-31).

Claim 20. The system of claim 17(Barka: pg. 2566, lines 1-3 and 11; D'Angelo: pg.534, abstract) wherein said means for determining, for each independent mode of the plurality of independent modes, a portion of a electromagnetic near -field contributed by each independent mode further comprises: means for coupling the impedance matrix for the reference pipe to another identical impedance matrix for the reference pipe to create an impedance matrix for a two-sided reference pipe having a common interface (D'Angelo: pg. 540, lines 14-24); means for solving the impedance matrix (D'Angelo: pg. 540, line 1-8) for the two-sided reference pipe by introducing the incident wave at the common interface of the two reference pipes (Barka: pg. 2566, lines 20-24); and means for determining the difference between the solution of the impedance matrix for the reference pipe, test fixture and aircraft engine component and the solution of the impedance matrix for the two-sided reference pipe (D'Angelo: pg.536, equation 13 with pg. 536, lines 1-4 and figures 1 and 2 and pg. 540, lines 1-8).

(10) Response to Argument

Appellants allege that the prior art fails to teach a plurality of independent modes (appellants' arguments, page 8, lines 12-29) and that the passing matrix is not a transformation of the finite element model (pg. 8, lines 23-4). The Office the latter argument since there's no limitation of a passing matrix within any of the claims.

Regarding the transformation and changing of the scattering matrix with passing matrix (appellants' arguments, page 9, lines), the examiner agrees with the appellants response stating that the "transformation into a plurality of independent modes and not just a transformation" (appellants' argument, pg. 9, lines 7-10); however, the examiner argues that the changing of a scattering matrix produces a different end product whereas a transformation could produce the same or a different end product in regards to the independent mode. Nowhere within the specification, or the claims, is there a distinction between the scattering matrix and the transformation nor a detailed definition of the independent mode.

Appellants argues that the D'Angelo article cannot teach or suggest the limitation of the "transformation of independent modes and the determination of the electromagnetic field for each independent mode as the D'Angelo article does not teach or suggest an independent mode as acknowledged by the examiner in the outstanding office action by referring to the Barka article" (pg.9-10, lines 23-29, lines 1-2, respectively). The examiner refutes appellants point to declare that the location of which art teaches which limitation is irrelevant.

In response to appellants' (pg. 10, 2nd paragraph) issue regarding D'Angelo's alleged lack of teaching of an electromagnetic field, the examiner fails to comprehend the distinction between the incident field and the electromagnetic field since both are moving current, which is a man-made source. Furthermore, to answer the summing of magnetic field, equation 7 on page 535, bottom equation appears to be a summing of the H-field (magnetic field).

Appellants denote that the examiner has added a different motivation to combine the references (pg.10, 3rd paragraph to pg. 11, 4th paragraph). In response, the examiner wrote a summary motivation statement to simply negate verbosity. Furthermore, as long the motivation to combine is sourced from the references, there's no impermissible hindsight reasoning (appellants' argument: pg.11, 5th paragraph to page 12, lines 1-24).

In response to appellants issue on page 13, 3rd paragraph, the examiner relied on an outside source to equate equations 7 and 8 as a non-integral form of a discrete Fourier Transform. Examiner apologies. However, the examiner points to equation 20 of the D'Angelo reference as evidence of record.

Appellants argue that neither reference teaches claim 6's limitation of a reference pipe of infinite length, which allege, is distinct from D'Angelo reference. (appellants' arguments, pg.14, paragraphs 1-2). Webster dictionary defines pipe, for one, as " a tubular or cylindrical object, part,". By analysis, The "finite circular cylinder" stated by D'Angelo is no different from a reference pipe as depicted within claim 6.

Appellants argue that neither reference teaches an axi-periodic structure (pg. 14, 3rd paragraph). Clearly, the D'Angelo reference teaches a axisymmetric body with azimuthal potentials (D'Angelo: pg. 534, left column, Introduction, 2nd paragraph, lines 11-12) radiating in a symmetrical fashion.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Thomas H. Stevens

Examiner

Art Unit 2123

January 3, 2006

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